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Assimilating ambiguous observations to jointly estimate groundwater recharge and conductivity

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In coupled modelling of catchments, the groundwater compartment can be an important water storage as well as having influence on both rivers and evapotranspirational fluxes. It is therefore important to parameterize the groundwater model as correctly as possible. Primarily important to regional groundwater flow is the spatially variable hydraulic conductivity. However, also the groundwater recharge, in a coupled system coming from the unsaturated zone but in a stand-alone groundwater model a boundary condition, is also of high importance. As with all subsurface systems, groundwater properties are difficult to observe in reality and their estimation is an ongoing topic in groundwater research and practice. Commonly, we have to rely on time series of groundwater head observations as base for any parameter estimation. Heads, however, have the drawback that they can be ambiguous and may not uniquely define the inverse problem, especially if both recharge and conductivity are seen as unknown.

In the presented work we use a 2D virtual groundwater test case to investigate how the prior knowledge of recharge and conductivity influence their respective and joint estimation as spatially variable fields using head data. Using the Ensemble Kalman filter, it is shown that the joint estimation is possible if the prior knowledge is good enough. If the prior is erroneous the a-priori sampled fields cannot be corrected by the data. However, it is also shown that if the prior knowledge is directly wrong the estimated recharge field can resemble the true conductivity field, resulting in a model that meets the observations but has very poor predictive power. The study exemplifies the importance of prior knowledge in the joint estimation of parameters from ambiguous measurements.